

DESCRIPTION

DIGITAL BROADCASTING SYSTEM

Technical Field

This invention relates to a digital broadcasting system and a digital broadcasting method for transmitting by a transmitter and for receiving by a receiver a terrestrial broadcast of program services of a succession of a plurality of events provided in the form of a transport stream. It also relates to a transmitter for transmitting the terrestrial broadcast and a receiver for receiving the terrestrial broadcast.

Background Art

Terrestrial television broadcast or radio broadcast often uses a plurality of antennas for transmitting same programs because the service area of a single broadcast wave is limited. If the broadcast waves transmitted from the respective antennas have a same frequency, interference can occur in any areas where two or more than two service areas overlap one another. Then, noise can arise in the received sound and a so-called "ghost phenomenon" of multiplexed images can occur.

In view of this problem of terrestrial broadcasting, broadcast waves are conventionally transmitted by using different frequencies for them particularly in adjacent service areas in order to avoid interference of broadcast waves. Thus, when a receiver of a conventional terrestrial broadcasting system is moved from the service

area of an antenna to that of another, it has to be tuned in to the frequency of the broadcast wave of the service area where the receiver is currently located.

Meanwhile, in recent years, research efforts have been paid for commercializing digital terrestrial broadcasting utilizing the MPEG-2 Systems (ITU-T H.222.0, ISO/IEC 13818-1) which is a compression transmission standard for audio and video information.

Since digital terrestrial broadcasting is adapted to transmit high quality sounds and images much better than conventional analog terrestrial broadcasting, there is a strong demand for digital terrestrial broadcasting systems. Additionally, digital terrestrial broadcasting can transmit various data to be utilized by way of computers and information terminals beside audio and video information. In other words, it can be used to transmit variety of combinations of different contents to provide various broadcasting services.

In the field of digital terrestrial broadcasting utilizing the MPEG-2 Systems, each broadcast unit such as a news coverage or a drama that starts and ends at predetermined respective hours is referred to as event and a given succession of a plurality of events is referred to as service. Many services are transmitted in the form of a transport stream. In the following description, the term "service" is reworded by "program" in order to avoid confusion between "service" and "service area".

Now, digital terrestrial broadcasting can be used by a same broadcaster to provide different programs in each service area because various contents can be

combined and broadcast digitally with ease.

Then, if an audience enjoying an event being broadcast through a given channel in a service area moves into another service area, he or she may no longer be able to receive the event in the new service area. For instance, if an audience receiving a "cooking program" as an event transmitted through a given channel in a service area moves to an adjacent service area, he or she may now be forced to receive a "night base ball game coverage" transmitted through the same channel in the new service area.

Additionally, a plurality of affiliated broadcasters may broadcast a same event at a same time. However, if an audience receiving the event in a service area of a specific broadcaster moves into an adjacent service area where some other broadcaster is broadcasting the same event, he or she will have to carry out cumbersome operations for making his or her receiving set adapted to properly receive the broadcast of the event in that area. That is, the receiving set temporarily falls into the state in which it cannot receive the terrestrial broadcast signal. Then, the audience may stop receiving the terrestrial broadcast signal or switch to receive a terrestrial broadcast signal transmitted by another broadcaster.

Disclosure of the Invention

In view of the above identified circumstances, it is therefore an object of the present invention to provide a digital broadcasting system and a digital broadcasting

method that makes continuous reception of a digital terrestrial broadcast program possible without requiring cumbersome operations if an audience moves from a service area into another.

Another object of the present invention is to provide a transmitter for digital broadcasting and a receiver for receiving such digital broadcast.

In an aspect of the present invention there is provided a digital broadcasting system for transmitting by a transmitter and for receiving by a receiver a program prepared by arranging a continuous succession of events in the form of a transport stream for terrestrial broadcasting; said transmitter being adapted to provide said transport stream with link information showing the links between said transport stream of a program or events being broadcast in the service area of the transmitter for terrestrial broadcasting and the programs being broadcast in adjacent service areas; said receiver being adapted to select a program being transmitted in said adjacent service area on the basis of said link information added to the transport stream being transmitted in said service area when moves into one of the adjacent service areas.

In another aspect of the invention, there is provided a digital broadcasting transmitter for transmitting a program prepared by arranging a continuous succession of events in the form of a transport stream for terrestrial broadcasting, said transmitter comprising: a link information providing means for providing said transport stream with link information showing the links between said transport stream of a program or events being transmitted in the service area of terrestrial broadcasting and the

programs being transmitted in adjacent service areas.

In still another aspect of the invention, there is provided a digital broadcasting receiver for receiving a program prepared by arranging a continuous succession of events in the form of a transport stream for terrestrial broadcasting, said receiver comprising: a link information extraction means for extracting the link information showing the links between said transport stream, program or events being transmitted in the service area of terrestrial broadcasting and the programs being transmitted in adjacent service areas; and a program selection means for selecting a program being transmitted in an adjacent service area on the basis of said link information added to the transport stream being transmitted in said service area when said receiver moves into said adjacent service area.

In still another aspect of the invention, there is provided a digital broadcasting receiver for receiving a program prepared by arranging a continuous succession of events into a transport stream by means of a terrestrial, said receiver comprising: a link information extraction means for extracting the link information showing the links between said transport stream of a program or events being transmitted in the service area of terrestrial broadcasting and the programs being transmitted in adjacent service areas; and a program selection means for giving priorities to the links by referring to said link information and selecting a program being transmitted in an adjacent service area on the basis of said priorities when said receiver moves into said adjacent service area.

In a further aspect of the invention, there is provided a digital broadcasting method for transmitting a transport stream as terrestrial digital broadcasting, the transport stream containing a program prepared by arranging a continuous succession of events into a transport stream, said method comprising: generating a transport stream provided with a link descriptor describing information on adjacent service areas and adapted to replace said transport stream, program or events being broadcast in the service area; and transmitting said transport stream provided with said link descriptor.

Brief Description of the Drawings

FIG. 1 is a schematic illustration of a digital broadcasting system according to the invention.

FIG. 2 is a schematic functional block diagram of a transmitter according to the invention and adapted to be used as a digital transmitter according to the invention.

FIG. 3 is a schematic illustration of a transport stream that can be transmitted by the transmitter of FIG. 2.

FIG. 4 is a schematic illustration of an NIT that can be contained in a transport stream that can be transmitted by the transmitter of FIG. 2.

FIG. 5 is a schematic illustration of a terrestrial delivery list that can be included in the NIT of FIG. 4.

FIG. 6 is a schematic illustration of a service list that can be included in the NIT of FIG. 4.

FIG. 7 is a schematic illustration of a link descriptor that can be included in the NIT of FIG. 4.

FIG. 8 is a schematic illustration of an example of link information with which a transport stream that is to be transmitted by the transmitter of FIG. 2 can be provide.

FIG. 9 is a schematic illustration of another example of link information with which a transport stream that is to be transmitted by the transmitter of FIG. 2 can be provide.

FIG. 10 is a schematic functional block diagram of a receiver according to the invention and adapted to be used as a digital receiver according to the invention.

FIG. 11 is a flow chart of a typical operation of the receiver of FIG. 10.

FIG. 12 is a flow chart of an operation of the receiver of FIG. 10 to be conducted when the receiver determines the priorities of various programs.

Best Mode for Carrying out the Invention

Now, the present invention will be described by referring to the accompanying drawings that illustrate the presently best mode of carrying out the invention. The present invention is suitably applicable to a digital broadcasting system 1 as shown in FIG. 1. Note, however, that the applicability of the present invention is by no means limited to a digital broadcasting system 1 as shown in FIG. 1 and the invention can be applied broadly to various systems adapted to transmit and receive digital terrestrial broadcasts. More specifically, the present invention is applicable to television

broadcasting adapted to transmit moving images and sound information in combination, radio broadcasting adapted to transmit only sound information, data broadcasting adapted to transmit various data that can be utilized by way of computers and other information terminals and multimedia broadcasting that is a combination of television or radio broadcasting and data broadcasting.

Referring to FIG. 1, the digital broadcasting system 1 is so designed that a plurality of broadcasting stations 10, 20, 30 digitally transmit respective terrestrial broadcasts, which are received at least by a receiver 100.

The broadcasting stations 10, 20, 30 are provided with respective transmitters that transmit respectively broadcast waves by way of antennas. The broadcast waves transmitted from the broadcasting stations 10, 20, 30 have respective limited service areas 10a, 20a, 30a where the receiver 100 can effectively be used for receiving the transmitted respective signals.

The terrestrial broadcast transmitted from each of the broadcasting stations 10, 20, 30 is a digital terrestrial broadcast utilizing the MPEG-2 Systems (ITU-T H.222.0, ISO/IEC 13818-1) which is a compression transmission standard for audio and video information.

In the field of digital terrestrial broadcasting utilizing the MPEG-2 Systems, each broadcast unit such as a news coverage or a drama that starts and ends at predetermined respective hours is referred to as event and a given succession of a plurality of events is referred to as service. Many services are transmitted in the form

of a transport stream. In the following description, the term "service" is reworded by "program" in order to avoid confusion between "service" and "service area".

With the illustrated digital broadcasting system 1, when the receiver 100 moves from the service area 10a into the service area 20a that is located next to the service area 10a, it can no longer receive the terrestrial broadcast being transmitted from the broadcasting station 10. Instead, it can receive the terrestrial broadcast being transmitted in the service area 20a.

In such a case, with a conventional terrestrial broadcasting system, the receiver is required to be operated for switching the reception frequency in order to properly receive the terrestrial broadcast being transmitted in said adjacent service area after the move into the adjacent service area. Such a switching operation is required each time the receiver moves from a service area into an adjacent service area.

Particularly, in recent years, various receivers for receiving terrestrial broadcasts have been down-sized and made lightweight so as to be mounted on various portable and mobile type information terminals. When a car navigation system of an automobile is provided with a receiver or a portable and mobile information terminal provided with a receiver is used in an automobile or a train, it will move by a long distance in a short period of time. In other words, it will move quickly and frequently from a service area into another so that the cumbersome switching operation will have to be repeated frequently to a great disadvantage on the part of the user.

However, with the digital broadcasting system 1 according to the invention, the

transmitter of each of the broadcasting stations 10, 20, 30 is adapted to transmit the transport stream with link information showing link between the transport stream, program or events being broadcast in its service area for terrestrial broadcasting and the programs being broadcast for terrestrial broadcasting in adjacent service areas and the priorities of the various links. Additionally, the receiver 100 is so adapted that, when it moves from a service area where it is receiving a terrestrial broadcast into an adjacent service area, it receives the program being transmitted in the adjacent service area where it is now located by referring to the link information contained in the transport stream.

Therefore, the broadcaster running the broadcasting stations can select in advance the program to be broadcast in the adjacent service area 20a and hence linked to a specific transport stream, program or events to be broadcast in the service area 10a and contain it in the link information. Then, as the transport stream is provided with the link information and broadcast from the broadcasting station 10, the receiver 100 can automatically receive the program being transmitted in the adjacent service area 20a that is linked to the transport stream, program or events transmitted in the service area 10a when it moves from the service area 10a into the adjacent service area 20a.

Similarly, if a number of affiliated broadcasters broadcast a same event simultaneously, the receiver 100 can automatically receive the transmission of the event if it moves from the service area 10a into the adjacent service area 20a.

Thus, it is now possible to freely and flexibly link the terrestrial broadcasting operations in the service area 10a and the adjacent service areas 20a, 30a. Therefore, if the receiver 100 moves from a service area to another, it can continue receiving appropriate programs so that the user of the receiver will not stop watching or listening to a program nor tuning in to some other station because no interruption of transmission occurs, if temporarily.

As described above, with the digital broadcasting system 1, the transmitter of the broadcasting station 10 provides the transport stream being transmitted with link information showing the link between said transport stream, program or events being broadcast in the service area 10a of the transmitter for terrestrial broadcasting and the programs being broadcast in adjacent service areas 20a, 30a. Additionally, the link information shows the priorities of the programs in the service areas. For examples, the program being transmitted in the adjacent service area 20a may have priority "1", while the one being transmitted in the adjacent service area 30a may have priority "2".

When the receiver 100 moves from the service area 10a into the adjacent service area 20a, it identifies the program being transmitted in the adjacent service area 20a by detecting the link between the program and the one being transmitted in the service area 10a on the basis of the link information contained in the transport stream it has received in the service area 10a.

If it is not possible for the receiver 100 to make clear if the place where it moves in is in the adjacent service area 20a or the adjacent service area 30a, it may

have to find out (search) which of the programs being transmitted in the service areas 20a, 30a can be received by referring to the link described in the link information. Then, it will try to find out the right program by sequentially searching the programs according to the priority of link so that the link that the broadcaster gives the highest priority will be tried first.

Therefore, it is preferable to give the highest priority to the program that is broadcast in the adjacent service area where the receiver most probably moves in, taking the geographical conditions of the service areas. Then, the receiver 100 will firstly search the program of the service area having the highest priority to consequently reduce the time necessary for the search operation.

More specifically, if there are a number of adjacent service areas, it is preferable to give the highest priority to the adjacent service area that is located in an administrative unit region (city, town, village) same as that of the original service area or the adjacent service area that is conveniently accessible from the original service area because the two service areas are linked by high ways and/or railways. Conversely, low priority may be given to the adjacent service areas that are not easily accessible from the original service area because of interposition of mountains and/or waters.

According to the present invention, link information does not necessarily indicate a single link in each adjacent service area. Two or more than two transport streams or a transport stream containing a plurality of programs may be transmitted

in each service area. Then, two or more than two programs will be broadcast in each service area.

If such is the case, the link information will show the links of the two or more than two programs in the adjacent service area in addition to the link between the original service area and the adjacent service area. Then, priorities will be given to all the programs in the same adjacent service area and the link information will contain these priorities.

When a number of programs are broadcast in an adjacent service area, the highest priority is preferably given to the link of broadcasting a same event in the original service area and the adjacent service area or, if not a same event, similar events of a same category such as "cooking program" or "night base ball game coverage". Priorities may be given in the order of the link in the adjacent service area of transmitting same events in all time slots, that of currently transmitting a same event in a same time slot although the different events may be transmitted in other time slots and that of transmitting different events of affiliated broadcasters.

As described above, according to the invention, the transmitter of each of the linked broadcasting stations provides the transport stream being transmitted from it with link information showing the links between its own transport stream and the programs being transmitted in adjacent service areas and the priorities given to the links. Therefore, if a receiver moves from the original service area into an adjacent service area, it can efficiently switch to the program being transmitted in the adjacent

The audio encoder 51, the video encoder 52 and the data encoder 53 respectively receive an audio signal, a video signal and a data signal and process them for compression coding before they output digital data. The audio signal, the video

The channel coding unit 55 processes the transport stream produced from the multiplexer unit 54 for error correction coding and subsequently for interleaving for

In the transmitter 50, the processing operation of the audio encoder 51 and that of the video encoder 52 conform respectively to the MPEG Audio and the MPEG Video, while the processing operation of the multiplexer unit 54 conforms to the

According to the invention, the link information is not necessarily put into the

link descriptor described in an NIT. It is only necessary for the link information to be added to a predetermined position of the transport stream. However, conventionally, an NIT contains a link descriptor in a region to be used for describing information necessary for identifying the service provided in response to a request of a receiver for additional information relating to any specific item described in the SI (service information). Therefore, a transport stream can be easily provided with link information by describing the link information in the link descriptor of the NIT of the transmitter 50.

Now, an NIT will be described briefly by referring to FIG. 4. An NIT has a data structure as shown in FIG. 4 according to the MPEG-2 Systems and transmitted by a TS packet whose PID is equal to "0x0010". In FIG. 4, [table_id] is the identifier for identifying the type of the network information section. A value of "0x41" is described when the NIT is that of its own network, whereas a value of "0x41" is described when the NIT is that of some other network. In other words, when link information on its own network is contained in the NIT, the link information has to be added to the network information section with "0x40".

In FIG. 4, [section_syntax_indicator] is the identifier for identifying the section syntax indicator and its value is constantly equal to "1", whereas [section_length] is the identifier for identifying the number of bytes from immediately after the section length field to the tail end of the section containing CRC (cyclic redundancy check). [network_id] is the identifier for identifying the distribution system indicated by the

NIT and discriminate it from other distribution systems.

[version_number] is the identifier for identifying the version number of the subtable. [current_next_indicator] indicates that the sub-table is the current sub-table when it is equal to "1" and that the sub-table being sent is not applicable and the next sub-table is to be used when it is equal to "0". [section_number] is the identifier for identifying the section number. The value of "0x00" is given when the section is the first section in the sub-table. "1" is added to the section number each time a section having same [table_id] and [network_id] is added.

[last_section_number] is the identifier for identifying the last section, or the section having the largest section number, of the sub-table to which the section belongs. [network_descriptors_length] is the identifier for identifying the total number of bytes of the loop of the network descriptors (descriptor ()) that follow. [transport_stream_loop_length] is the identifier for identifying the total number of bytes of the transport stream loop that ends immediately before the first byte of the CRC.

[transport_stream_id] in the transport stream loop is the identifier for identifying the transport stream from the multiplexed other transport streams in the distribution system. [original_network_id] is the identifier for showing the [network_id] of the original distribution system. [transport_descriptors_length] is the identifier for identifying the total number of bytes of the loop of the network descriptors that follow. [CRC_32] is the identifier for indicating the CRC having a

Thus, the receiver 100 can switch from the program (service) it is receiving

currently to some other program (service) by referring to the terrestrial delivery system list and the service list.

Note that the NIT does not need to describe all the information on the transport streams being transmitted in all the service areas by means of a terrestrial delivery system list and a service list. Alternatively, it may describe only the transport streams being transmitted in some service areas. For example, the NIT may be made to describe information on the transport streams being transmitted in the original service area and the adjacent service areas by means of a terrestrial delivery system list and service list.

Limiting the information contained in the terrestrial delivery system list and the service list provides the following advantage.

A bit rate of about 20 Mbps is currently used for satellite broadcasting such as BS broadcasting and CS broadcasting. Therefore, transport streams of satellite broadcasting are made to contain SI (service information) and PSI (program specific information). However, the bit rate will be as low as about 400 kbps for digital terrestrial radio broadcasting.

If the SI and PSI of all the programs (services) of a delivery system is transmitted as in the case of BS and CS broadcasting, the transmission bandwidth will practically have to be dedicated to the SI and PSI to remarkably reduce the efficiency of transmitting a proper program. The efficiency of transmitting a proper program can be maintained by limiting the volume of information on other programs (services)

Now, a link descriptor will be described. A link descriptor is defined by the ARIB on the basis of the descriptor format defined in the MPEG-2 Systems. It has a data structure as shown in FIG. 7 (ARIB STD-B10).

[transport_stream_id] is the identifier for identifying the transport stream containing the information service indicated by the link descriptor. [original_network_id] is the identifier for identifying the network of the original delivery system of the information service indicated by the link descriptor. [service_id] is the identifier for identifying the programs contained in the transport stream indicated by the [transport_stream_id] if the transport stream contains more than one programs (services). [linkage_type] is the identifier for identifying the link information including the link type. [private_data_byte] is the identifier having an individually defined value.

While a link descriptor has a data structure conforming to the provision of the MPEG-2 Systems as described above, the existing digital broadcasting systems have not discussed about how to use link descriptors. In other words, the existing digital broadcasting systems do not use link descriptors.

On the other hand, a transmitter 50 according to the invention provides a transport stream with link information by using link descriptors. Now, link information that is used for the purpose of the present invention will be discussed below.

For the purpose of the invention, link information has a table structure as shown in FIG. 8. Referring to FIG. 8, link information contains service area IDs for identifying the service areas adjacent to the original service area and service IDs for identifying the programs (services) to be linked in the respective adjacent service areas.

More specifically, referring to FIG. 1, service area ID "area 20" is given to the service area 20a of the broadcasting station 20 while service area ID "area 30" is given to the service area 30a of the broadcasting station 30. When the receiver 100 moves from the original service area 10a into the adjacent service area 20a, it refers to the link information and selects the program (service) with service ID "service 5" of the service area ID "area 20" for reception.

In the link information shown in FIG. 8, the programs (services) with service IDs "service 5" and "service 13" are those being transmitted in the service area 20a,

Link information may have a table structure as shown in FIG. 9 instead of the table structure shown in FIG. 8. Unlike FIG. 8, where the order of appearance

of the service IDs in the table structure indicates the priorities given to them, a column of "priority" is shown in the table of FIG. 9 to indicate the priorities given to the linked programs (services). In FIG. 9, the service with service ID "service 18" has the highest priority and is followed by the service with service ID "service 5" and the service with service ID "service 13".

When a "priority" column is provided in the link information, identifiers [linkage_type]s and [private_data_byte] may be used to describe the "priority".

Additionally, by providing a "priority" column in the link information, it is possible to give priorities to a number of links. For example, priority "1" may be given to two linked services with service IDs "service 5" and "service 18".

Thus, the transmitter 50 according to the invention transmits its service with an NIT containing link information describing links between [the transport stream being transmitted in the original service area] and [the programs (services) contained in the respective transport streams being transmitted in the adjacent service areas] and the priorities given to them.

Therefore, when the transport stream 1 of the original service area being transmitted contains a single program (service), the program is linked to some other program. On the other hand, when the transport stream 1 contains two or more than two programs (services), the transport stream 1 itself is linked to some other program (service). When, it is not possible to specify a specific program (service) out of the programs (services) contained in the transport stream.

Then, the transmitters 50 according to the invention may provide the SDT (service description table) with link information instead of providing the NIT with link information. The SDT is a table showing information on the programs (services) contained in the transport stream and defined by the (ARIB STD-B10) on the basis of the basic table structure that is defined in the MPEG-2 Systems. Then, the transmitter 50 can link each of the programs (services) contained in the transport stream to a program (service) in an adjacent service area.

Still alternatively, the transmitter 50 according to the invention may provide the EIT (event information table) with link information. The EIT is a table showing information on each of the events contained in the program (service) or each of the programs (services) contained in the transport stream and defined by the ARIB (ARIB STD-B10) on the basis of the basic table structure that is defined in the MPEG-2 Systems. The transmitter 50 can set the programs (services) on each of the events in the adjacent service areas by providing the EIT with the link information.

Thus, it is possible to use link descriptors for describing link information when providing the SDT or EIT with the link information as in the case of providing the NIT with the link information.

Now, the receiver 100 adapted to receive the terrestrial broadcast transmitted by the transmitter 50 will be described. FIG. 10 shows a receiver 100 realized by applying the concept of digital broadcasting receiver according to the invention.

As shown in FIG. 10, the receiver 100 comprises a demodulator unit 101 for

receiving a terrestrial broadcast signal transmitted from the transmitter 50 and for digitally demodulating the broadcast signal, a decoding unit 102 for decoding the signal digitally demodulated by the demodulator unit 101 and taking out the transport stream, an extracting unit 103 for extracting the digital data multiplexed in the transport stream taken out by the decoding unit 102 and producing an output corresponding to the digital data, an audio decoder 104 for receiving the digital data extracted by the extracting unit 103 and generating an audio signal, a video decoder 105 for also receiving the digital data extracted by the extracting unit 103 and generating a video signal, a data decoder 106 for also receiving digital data extracted by the extracting unit 103 and generating a data signal, a GPS (global positioning system) receiving unit 107 for detecting the current position of the receiver on the basis of the signal transmitted from the GPS, a memory 108 for storing the link information contained in the transport stream and a system controller 109 for controlling the operation of each of the components of the receiver 100.

The demodulator 101 corresponds to the modulator 56 of the transmitter 50 and is adapted to process the broadcast signal input through the reception antenna 120 for digital demodulation.

The decoding unit 102 corresponds to the channel coding unit 55 of the transmitter 50 and is adapted to process the digitally decoded signal from the demodulator 101 for deinterleaving and error correction decoding and take out the transport stream.

The extracting unit 103 extracts each of the TS packets on the basis of the PIDs (packet identification numbers) carried by the respective TS packets in the transport stream input from the decoding unit 102 and determines if the digital data contained in each of the TS packets belongs to an audio signal or a video signal. Then, it sends the digital data contained in the packet to either the audio decoder 104 or the video decoder 105, whichever appropriate. The extracting unit 103 also extracts the NIT contained in the transport stream and sends the information contained in the NIT to the system controller 109. Similarly, the extracting unit 103 also extracts the SDT and the EIT contained in the transport stream and sends the information contained in the SDT and EIT to the system controller 109.

The audio decoder 104, the video decoder 105 and the data detector 106 process the respective digital data input from the extracting unit 103 for decoding and generate an audio signal, a video signal and a data signal respectively.

It will be appreciated that the receiver 100 does not need the video decoder 105 and the data decoder 106 when the broadcasting stations are radio broadcasting stations and adapted to transmit only sound information.

The GPS receiving unit 107 receives the signal transmitted from the GPS (global positioning system) and detects the current position of the receiver 100 on the basis of the signal. With the provision of the GPS receiving unit 107, the receiver 100 can reliably detect its current position. Therefore, if there are a number of adjacent service areas that are located close to the original service area where it is receiving a

transport stream, it can immediately determine the adjacent service area that is closest to the original service area. Then, the receiver 100 can optimally select the adjacent service area for receiving a program (service) at the current position out of the plurality of adjacent service areas by referring to the link information contained in the NIT. Thus, it can immediately receive the linked program (service) of the adjacent service area.

It should be noted, however, that the receiver 100 is not limited to comprising a GSP receiving unit 107. Alternatively, it may be so adapted that the receiver 100 receives a reference signal transmitted from a predetermined terrestrial broadcasting station and detects its current position on the basis of the reference signal. Still alternatively, it may be so arranged that the receiver 100 is provided with an input section for receiving various pieces of information including the postal code, the telephone area code, the name of the prefecture and that of the service area of the current position and determines the current position on the basis of any of such pieces of information.

Still alternatively, the receiver 100 may not be provided with means for detecting the current position where it is receiving a terrestrial broadcast. If such is the case, the receiver 100 sequentially tries to see which of the linked programs (services) belonging to the adjacent service areas can be received on the basis of the link information contained in the NIT and selects the program (service) it can receive optimally.

It will be appreciated that the present invention is by no means limited to that the receiver 100 determines that it has moved out of the original service area when the

signal reception level of the output of the demodulating unit goes under a predetermined level. For instance, it may alternatively be so arranged that the receiver 100 determines if it has moved out of the original service area or not on the basis of the current position as detected by the GPS receiving unit 107.

Additionally, the receiver 100 may be so arranged that the system controller 109 gives priorities to various links according to its own decision by referring to the link information contained in the received transport stream. If such is the case, the receiver 100 can decide the priorities to be given to various links if the link information shows only links without their respective priorities levels.

When the receiver 100 decides priorities of its own accord, preferably the system controller 109 stores the history of moving among the service areas in the memory 108 and gives high priorities to the links of the service area where it will move frequently by referring to the link information and the moving history. Alternatively, it may be so arranged that the system controller 109 stores the predetermined priorities given respectively to the service areas in the memory 108 and gives higher priorities to the links of a service area having high priority by referring to the priority of each of the service areas and the link information. Still alternatively, it may be so arranged that the system controller 109 gives higher priorities to the links of a service area having a large number of links.

As the receiver 100 gives priorities to the service areas and the links of its own accord, it can reliably select an optimal link in the service area where it moves in so

that it can quickly and reliably switch to the program (service) it should receive.

Now, the operation of the receiver 100 having the above described configuration for switching from the program (service) it is currently receiving to another program (service) when it moves from a service area to another will be described by referring to the flow chart of FIG. 11.

Firstly, as the system controller 109 of the receiver 100 judges that the signal reception level of the output of the demodulating unit 101 goes under a predetermined value or the receiver 100 has moved out of the original service area on the basis of the current position detected by the GPS receiving unit 107, it determines that it is difficult for the receiver 100 to satisfactorily receive the transport stream it has been receiving in the original service area in Step S1 as shown in FIG. 11.

Then, the system controller 109 proceeds to Step S2, where the GPS receiving unit 107 detects the current position of the receiver 100.

Subsequently, the system controller 109 moves to Step S3, where it selects the adjacent service area that covers the current position and identifies the "service ID" of the link of the adjacent service area to be selected by referring to the link information stored in the memory 108.

Then, in Step S4, it identifies the "TS_id" that corresponds to the "service ID" identified in Step S3 by referring to the service list shown in FIG. 6.

Thereafter, in Step S5, it identifies the "frequency", the "mode", the "guard interval" and other pieces of information corresponding to the "TS id" identified in

Subsequently, in Step S12, it identifies the "frequency", the "mode", the "guard interval" and other pieces of information corresponding to the "TS_id" identified in

latter stops tuning. Alternatively or additionally, it may be so arranged that a voice message is sounded from the loudspeaker of the receiver 100 for the same effect.

As described above, when the receiver 100 is not provided with a GPS receiving unit 107, it has to judge to which of the links contained in the link information can successfully tune in by carrying out a search operation. Then, the receiver 100 is forced to temporarily stop producing an audio signal and/or a video signal.

Therefore, it may be so arranged that the receiver 100 comprises at least a pair of demodulating units 101s 101 and one of the demodulating section searches a link for optimally receiving a program (service), while the other demodulating section keeps on receiving the current program (service) of the original service area in order to minimize the interruption of signal output.

With this arrangement, the possible interruption of signal output can be minimized for a search operation.

Now, the operation of the controller 109 of a receiver 100 having the above described configuration that it switches to some other program (service) by allocating priorities to the links contained in the link information when the receiver 100 moves into an adjacent service area will be described below by referring to the flow chart of FIG. 12.

Firstly, as the system controller 109 of the receiver 100 judges that the receiver 100 has moved out of the original service area because the signal reception level of the output of the demodulating unit 101 goes under a predetermined value or for some

other reason, it determines that it is difficult for the receiver 100 to satisfactorily receive the transport stream it has been receiving in the original service area in Step S21 as shown in FIG. 12.

Then, the controller 109 proceeds to Step S22, where it selects the link having the highest priority out of a plurality of links contained in the link information stored in the memory 108 and identifies the "service ID" of the link.

Thereafter, in Step S23, the controller 109 identifies the "TS_id" corresponding to the "service ID" identified in Step S22 by referring to the service list as shown in FIG. 6.

Subsequently, in Step S24, it identifies the "frequency", the "mode", the "guard interval" and other pieces of information corresponding to the "TS_id" identified in Step S23 by referring to the terrestrial delivery system list as shown in FIG. 5.

Then, in Step S25, the controller 109 causes the demodulating unit 101 to tune in to the program (service) of the selected link on the basis of the pieces of information identified in Step S24 and judges if the receiver 100 can receive the program (service) of the selected link well or not. Thereafter, the controller 109 proceeds to Step S26 when it judges that the receiver 100 can receive the program (service) well, whereas it proceeds to Step S27 when it judges that the receiver 100 cannot receive the program (service) well.

In Step S26, the controller 109 completes the operation of switching to the program (service) being transmitted in the adjacent service area where it has moved

in.

When the controller 109 proceeds to Step S27, it determines if an attempt at tuning in to all the links contained in the link information has been made or not. If the attempt has not been completed, the controller 109 returns to Step S22 and selects the link having the second highest priority to go on the tuning operation. If, on the other hand, the attempt at tuning in to all the links has been completed, the controller 109 proceeds to Step S28.

In Step S28, the controller 109 determines that it is difficult to receive any of the programs (services) of the links contained in the link information. Then, the receiver 100 either continues tuning in to the program (service) it has been receiving in the original service area or stops any reception. It may be so arranged that a message "no signal reception" is displayed on the display of the receiver 100 when the latter stops tuning. Alternatively or additionally, it may be so arranged that a voice message is sounded from the loudspeaker of the receiver 100 for the same effect.

As described above, the receiver 100 is required to judge to which of the links contained in the link information it can successfully tune in by carrying out a search operation. Then, the receiver 100 is forced to temporarily stop producing an audio signal and/or a video signal.

However, the receiver 100 can select a program (service) which can receive in the service area the receiver 10 has moved into, with an enhanced level of probability by searching the links, referring to the link information and the priorities allocated to

the links. Therefore, the interruption of the signal output for the search operation can be minimized and the optimal link can be searched efficiently.

It may be so arranged that the receiver 100 searches a link on the basis of the current location of itself as detected by the GPS receiving unit 107. Then, for example, if it is clearly known that the receiver 100 has moved out of the original service area 10a into the adjacent service area 20a as a result of the operation of the GPS receiving unit 107, the controller 109 searches the links in the service areas with service area IDs "area 20", starting from the link having the highest priority with service ID "service 5", by referring to the link information as shown in FIG. 8. With this arrangement, the time necessary for the search operation can be reduced further and the program (service) that can be received optimally can be reliably detected in the service area where the receiver 100 has moved in.

It may alternatively be so arranged that the receiver 100 does not automatically start a search operation, referring to the link information, but displays the links in the order of the priorities allocated to them. Then, the link to be tuned in may be selected according to the input operation at the input section.

Industrial Applicability

As described above in detail, with a digital broadcasting system and a digital broadcasting method according to the invention, a transport stream, program or events being broadcast in a service area is made to contain link information showing the links

of programs being transmitted in adjacent service areas so that, when a receiver moves from the original service area into an adjacent service area, it can receive a program being transmitted in the adjacent service area without cumbersome operations.

A digital broadcasting transmitter according to the invention can transmit a terrestrial broadcast containing link information showing the programs being transmitted in adjacent service areas that are linked to the transport stream, program or events being transmitted in the original service area by the link information providing means.

A digital broadcasting receiver according to the invention can receive a program being transmitted in the adjacent service area where it has moved in by referring to the link information extracted by its link information extracting means without cumbersome operations.

Thus, according to the present invention, when the receiver moves from the original service area into an adjacent service area, it can automatically receive a program in the adjacent service area relating to the transport stream, program or events being transmitted in the original service area when the broadcaster selects in advance programs in the adjacent service areas and links them to a specific transport stream, program or events. Additionally, if a plurality of affiliated broadcasters may broadcast a same event at a same time, the receiver can automatically receive the same event when it moves from the original service area into an adjacent service area.

Thus, it is now possible to freely and flexibly link the terrestrial broadcast being

transmitted in a service area and the terrestrial broadcasts being transmitted in adjacent service areas. Additionally, as the receiver can keep on receiving a program if it moves from the original service area into an adjacent service area, it is now possible to prevent an audience or a listener receiving a program from stopping the reception or switching to a terrestrial broadcast being transmitted by some other broadcaster when the reception is temporarily interrupted.